EFFECT OF ABNORMAL WEATHER CONDITIONS DURING THE CONSTRUCTION OF THE LOS ANGELES AQUEDUCT, ABSTRACTED FROM REPORT OF THE ENGINEERS.

By ALEXANDER G. MCADIE, Professor U. S. Weather Bureau.

As might reasonably have been anticipated on construction work stretching over a distance of 213 miles, there have been many accidents, though most of them have been comparatively unimportant. In only two instances have substantial failures of work occurred, and these were due to extremely unusual weather conditions, and not to defects in plan, workmanship, or materials. In July, 1911, while constructing the concrete regulating gate in the aqueduct, just below the point of diversion from Owens River, the river reached a height unknown for more than 30 years before, probably on account of the melting of a large body of snow in the mountains. By reason of the uncompleted condition of the work and the greenness of the cement just placed, the flood waters broke under and around the gate and ran down the canal for about 5 miles, where they were turned out and flowed back into the river. As soon as the flood subsided the gate was replaced, and additional construction in the way of sheet-steel piling and concrete shut-off walls, suggested by the experience from the flood, was put in. The total amount of damage to the work hardly exceeded $1,000; the additional construction mentioned cost about $3,400.

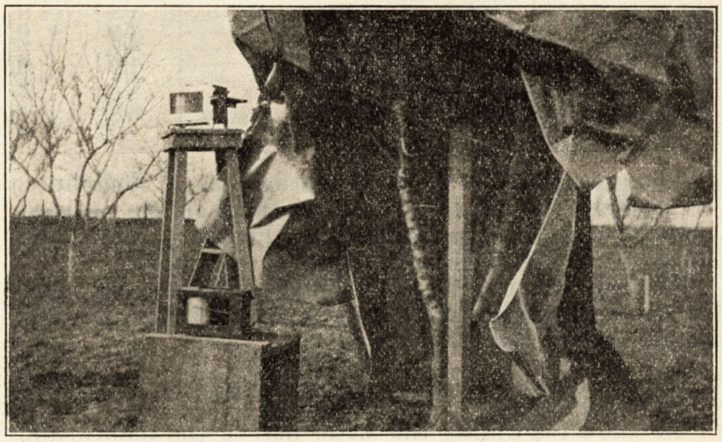
The other failure of work referred to occurred at the point where the aqueduct crosses what is known as "Tehachapi Wash," about 3 miles north of the town of Mojave. A section of conduit about 1,200 feet in length had been built across a delta composed of sand, gravel, and bowlders, which had been carried by flood waters from Tehachapi Canyon. As afterwards appeared, this material, though laid down by natural hydraulic process, had been left in an uncompacted condition, due to the rapid passage of the carrying agency. In the summer of 1910, after the construction of the section of conduit mentioned, a cloud-burst occurred in Tehachapi Canyon, resulting in a flood of water which ran down over the delta to the aqueduct work, where its passage was obstructed by the dump made by the steam shovels on the lower side of the trench. This caused the water to back up over the work to a depth of several feet, where it stood long enough to thoroughly saturate the ground around the conduit, and thus caused a subsidence of the formation. The concrete was cracked and fractured by this disturbance to an extent rendering it necessary to replace the work in the section mentioned, at a cost of $27,000. The cost of this reconstruction was somewhat excessive, due to the hardness and superior quality of the concrete, which required heavy blasting for its removal, holes being drilled in the corners of every 2 feet square and shot with dynamite. The broken concrete was then run through rock crushers and used as broken stone for the making of the concrete for the new line.

COVERING ALMOND TREES FOR FROST PROTECTION.

By ALEXANDER G. MCADIE, Professor U. S. Weather Bureau.

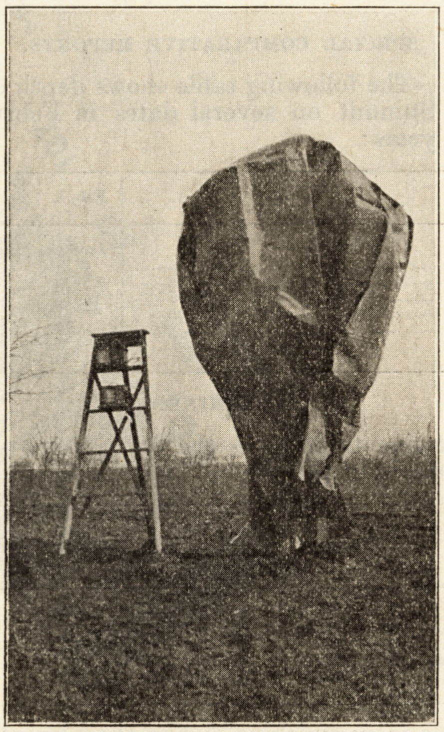
In previous papers on the subject of frost protection it was pointed out that one method of protection was by means of paper covers, a detailed account of which was given in the Pacific Rural Press of December 24, 1910. The argument advanced was that such a covering would intercept the long heat waves radiated from the earth on quiet, clear nights, and that there would be a certain absorption of the heat by the cover and a reemission. In brief, we could prevent a too rapid loss of heat by interference with free radiation, utilize the absorbed heat by reemission, and conserve the original heat supply of soil, tree, foliage, and the stratum of air within 15 feet of the ground.

The problem is a complicated one, as earth, tree, air, and water vapor gain and lose heat at varying rates. For the present we will neglect these points and give only the actual results of some experiments made during February and March, 1912, at the university farm at Davis, Cal.



COVERED TREE WITH EXPOSED INSTRUMENTS ADJACENT.

Instructor B. S. Brown had direct charge of the experiments, being assisted by Emile Grauel, orchardist. The almond trees, being in blossom, it was decided to cover one of them as shown in the illustration. The variety of the almond is the California Paper Shell. The paper used was a weatherproof manila and was first put on at 5 p. m. February 19, and removed at 9 a. m. February 21. It was again put on at 5 p. m. February 25, and removed



ALMOND TREE, SHOWING COVERING FOR TREE AND INSTRUMENTS INCLOSED.

at 8 a. m. February 26. Again put on at 6 p. m. of the 26th and left on until 8 a. m. March 1. It was found that it was practically impossible to put the cover on after dark, and it also developed that in a 10-mile breeze it took three men one hour to cover one tree.

Two thermographs were used, one giving the temperature under the cover and the other outside. From these records it appears that a minimum temperature of 19° F. occurred a little after 8 a. m. on Monday, February 26. Under the cover the temperature fell to 24° F. There is a general resemblance in the curves, and while the temperature under the cover was in every case higher than that outside, the difference is much less than was anticipated. It is plain that the loss of heat, while retarded by the cover, was not sufficiently decreased to warrant extensive use of the method in its present form.

Records of the humidity were also obtained, and these show the characteristic rapid increase in relative humidity during the frost period; thus at 4 p. m. February 25 the relative humidity was 20 per cent, at 6 p. m. 30 per cent, at 8 p. m. 45 per cent, at 10 p. m. 52 per cent, at midnight 60 per cent, at 2 a. m. 79 per cent, and then fluctuating between 80 and 87 per cent until 7 a. m., when there was a rapid drop to 70 per cent. Between 2 and 4 a. m. there appears to have been a slight gain in temperature; that is, about 2° F., which may possibly be connected with the latent heat of water, since in changing a pound of water to a pound of ice 143 British thermal units are set free.

In two respects the experiment needs further study. First, there would probably have been a greater difference between the temperatures if there could have been introduced under the cover a small supply of water heated to a temperature of about 80°. In the second place, if a slow-burning heater could have been placed under the cover and near the vessel containing the water we would probably have been able to prevent a fall below 35°. It may be noted that at 4 p. m., according to the records, the weight of the water vapor per cubic foot was 1.702 grains, at 6 p. m. 1.140 grains, at 8 p. m. 1.282 grains, at 10 p. m. 1.223 grains, at midnight 1.112 grains, at 2 a. m. 1.418 grains, and at 4 a. m. 1.548 grains. In a general way there was very little water vapor present.

Finally, it was noted that the rise in temperature on the various mornings, after the minimum temperature had been reached, was slower and less in degree under the cover than in the open air. For example, the temperature rose 23° from 6 to 8 a. m. in the open, and only 18° under the cover. This is a matter of some importance, as beyond doubt there is considerable danger to plant tissue when subjected to such a rapid warming after exposure to so low a temperature.

The time of sunrise was 6.45.

It has been suggested that in connection with the account of this experiment some data should be given regarding critical temperatures for various fruits at different periods. While it is within the province of the meteorologist to furnish accurate data regarding the temperature of the air and the degree of saturation, it is more properly the work of the plant pathologist to determine critical temperatures. Thus, according to Prof. W. L. Howard, the pathologist of the Missouri Experiment Station, after artificially freezing thousands of peach buds, summarized the critical temperatures as follows:

"Fully dormant peach buds can stand 8° or 9° below zero, Fahrenheit. When they are appreciably swollen zero is the danger point. When the buds are showing pink they can stand 15° above zero. When the buds are almost open 25° is the danger point. When they are newly opened about 26° would be the point of danger. When the petals are beginning to fall 28° above zero is cold enough to cause uneasiness. When the petals are off they can stand 30° above zero. When the 'shucks' (calyx lobes) are beginning to fall off, 32° is the danger point."

The writer is not aware of any set of similar experiments covering almonds. It is plain from the actual experiments made in the open at Davis that a temperature of 24° F. was critical, even though it lasted but 40 minutes. Referring to the actual record during the almond experiment given above, the temperature was below 32° practically from 10.45 p. m. February 25 until 6.45 a. m. February 26. Moreover, the fruit after sunrise was under cover and subjected only to a rise of 18° (from 24° F. to 42° F.) in less than one hour.

The reader is referred to an article in the Pacific Rural Press, April 30, 1910, entitled "How much freezing fruit will endure," for more detailed information regarding the danger point for apples.

But when all is said and done, temperature data, while instructive and in a way meeting the needs of the fruit grower, do not tell the whole story. The thermometer may give the temperature of the air, but the temperature of the tree or the temperature of the soil may be different. Then, again, temperature varies with height above the ground, and an instrument placed at the top of a tree may give much higher temperatures than an instrument placed in the middle of a tree or still lower and nearer the ground. Furthermore, the freezing point in ordinary use, that is, 32° on the Fahrenheit scale and zero on the Centigrade scale, is not necessarily the freezing point for water in the plant. As W. N. Shaw points out, it is the freezing point of water in the laboratory under carefully organized conditions. It is not the freezing point of water that covers four-fifths of the globe or of that in the harbors periodically blocked with ice. It is not the freezing point of the water contained in the cells of plants, which is probably different in different plants. Shaw instances one plant where it is 11° below 32°. In other words, the change of water from the liquid to the solid state is dependent upon certain physical conditions.

Finally, the writer would call attention to the difference between freezing as conducted artificially in the laboratory and the freezing which takes place in the open. In future experiments it will be necessary to take into account the rate of warming up after the blossom or fruit has been subjected to a freezing temperature. So far as we know, the present experiment of the covered almond tree at Davis is the first one in which records are available showing a difference in the rate of warming up. According to the record, the cover did not prevent rapid warming after sunrise, which was contrary to our expectation. While there was a difference between the inside and outside rates of warming, we are of the opinion that in this experiment, at least, the rate of warming was still too rapid. In some way the cover must be improved, so as to interpose a more effective barrier to insolation. This can be done by making the cover double, with an intervening air space.

In conclusion, while the almonds were lost, enough has come out of the experiment to warrant the statement that with proper care and improved methods fruits can be protected from the strains incident to rapid loss of temperature and rapid heating, within moderate limits.